Here Right Now: *Free* AM And FM Digital Radio

There's No Subscription Fee, And It's On Standard Analog Frequencies!

By Bruce A. Conti

AM and FM radio is available for free, with digital clarity and without a subscription. It's called HD Radio, and that's the message legacy AM/FM broadcasters are sending loud and clear through the advent of high-definition digital radio, coming soon to radio stations near you, if not already on the air. It's all in response to the growing popularity of subscription satellite radio.

FM radio stations are now multicasting with separate "HD2" secondary digital channels featuring commercial-free and unique music formats, such as lost oldies, disco fever, avant-garde jazz, and hardcore hip-hop, while providing a primary digital simulcast of the programming carried on standard analog frequencies. Digital technology also brings near FM-quality audio to AM, and near CD-quality audio to FM. It's HD Radio moniker is intended to piggyback on the public's familiarity with HDTV, and it's here now.

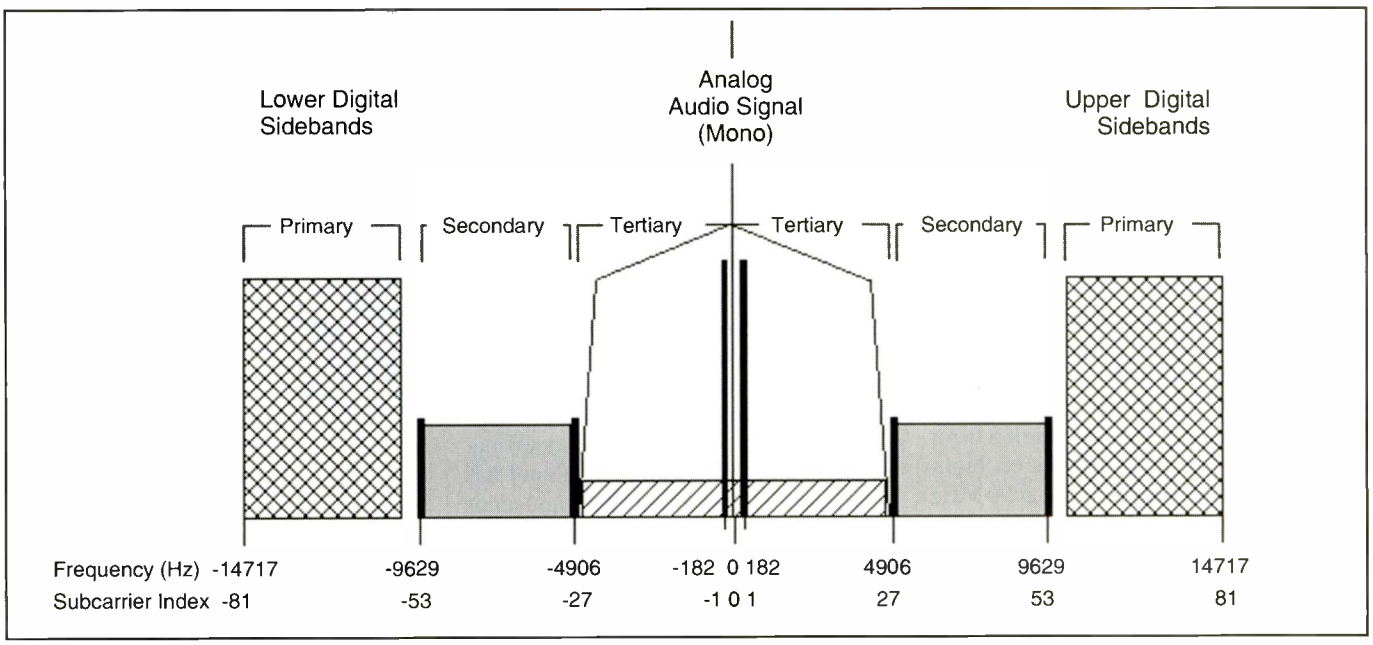
Brief History Of Digital Audio Broadcasting

Digital audio broadcasting (DAB) has been under development for well over a decade. At issue were a number of factors. What spectrum of radio frequencies was available for digital radio? What form would the digital signal take? What would happen to existing analog radio signals?

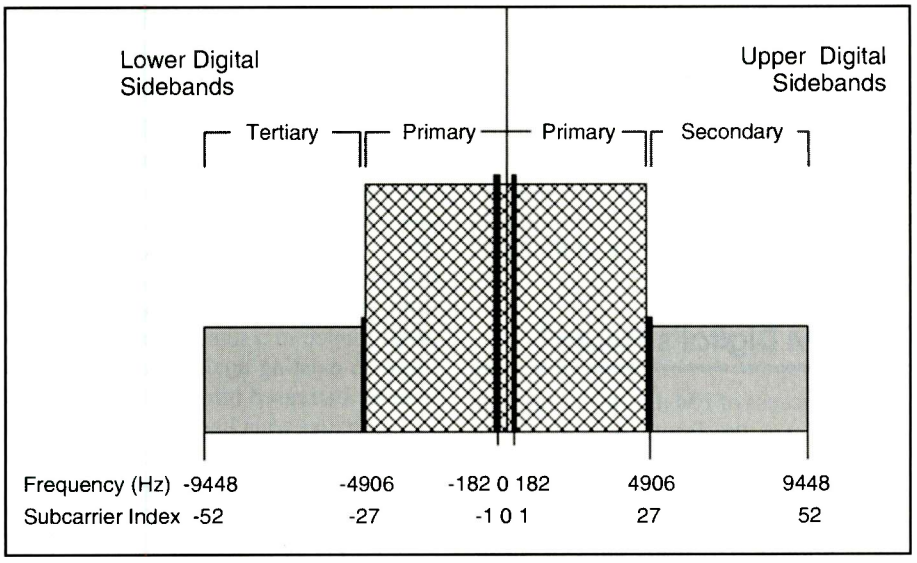
One ambitious model that surfaced early in the debate allowed for digital broadcasting within the AM and FM broadcast bands in coexistence with analog signals. The objective was to allow broadcasters to convert to digital in stages using their existing assigned frequencies without interruption of ongoing analog broadcasts. This would in effect bypass a lengthy application and reassignment process for digital frequencies in a new broadcast band, ultimately making the transition from analog to digital as smooth as possible for broadcasters and listeners alike.

The first major iteration of in-band AM/FM digital radio was developed by USA Digital Radio and demonstrated during the annual National Association of Broadcasters trade show in Las Vegas, Nevada, in 1995, some five years after the concept was first introduced. In that same year, DAB was successfully demonstrated on AM radio station 1660 KUSA, offering the promise of new high-performance music and data services "that are affordable, practical, backwards compatible with existing services and very low risk." (USA Digital Radio In-Band On-Channel Digital Audio Broadcast System Description, April 9, 1995.)

Fast-forward to 2001. Digital radio seemed clear for takeoff after opposing forces formed an alliance known as iBiquity Digital Corporation. Several revisions of the digital specifications



A look at the AM IBOC hybrid waveform. (All photos courtesy iBiquity Digital Corp.)



Here's an AM all-digital waveform.

led to something more closely resembling the European DRM in-band digital standard. However, not everyone was ready to accept the new DAB standard as the easy flight plan toward a digital destination. In-band, on channel DAB then won final approval by the FCC.

Digital's Dilemmas

There are two basic modes of AM/FM digital operation: hybrid and all-digital. In the hybrid mode, radio stations broadcast both the analog and digital signals on the same channel, or frequency, as the present analog-only transmission in the AM or FM broadcast band, hence the term "in band, on channel" (IBOC). While the original analog signal continues to be broadcast at its center frequency, a digital signal is simultaneously broadcast on the sidebands. This allows a radio station to begin digital broadcasting without losing its analog listenership, essentially making the initial conversion to digital transparent. The AM digital signal is pumped through the same transmitter as the AM analog signal, but a separate FM digital transmitter is interleaved with the FM analog transmission to handle the greater bandwidth of FM hybrid and an optional "extended hybrid" mode. In addition to the greater overall bandwidth used to carry both the analog and digital signals, the AM analog signal bandwidth is reduced to less than 10 kHz to provide more space for the digital signal.

Listeners using a wide bandwidth AM receiver will notice degradation in analog signal quality when a radio station is operating in the hybrid mode, most notably if the AM radio station was previously broadcasting a high-fidelity AM stereo signal. FM analog bandwidth, often already reduced to provide subcarrier information, can be further reduced for extended hybrid operation without noticeable analog signal degradation by other than the most discerning listeners.

By using the sidebands to carry the digital signal, the hybrid mode itself requires more bandwidth than the original analog-only signal, which has created some problems with transmission equipment and adjacent channel interference, especially for AM radio. Some AM/FM broadcast DXers have reclassified digital broadcasting as IBAC for "in band, adjacent channel" because the digital signal actually occupies adjacent channels, therefore making it not exactly confined to "on channel."

If you are within range of an AM or FM signal currently broadcasting in the hybrid mode, tune in to the channel or frequency at either side of the signal on an analog receiver to hear the digital hash. Interference on FM might be less obvious than on AM because FM has more space between channels, with a nominal bandwidth of 200 kHz versus the 10 kHz nominal AM bandwidth. For example, an FM hybrid signal at 89.7 MHz (say, WGBH Boston) can fill 89.5 to 89.9 MHz (0.400 MHz or 400 kHz wide) without spilling over to the next adjacent channel at 89.3 or 90.1 MHz, at least in theory.

Worse On AM

FM DXers have encountered digital spilling over wider frequency ranges; AM broadcasters don't enjoy the same luxury. Due to a nominal bandwidth of only 10 kHz, the AM hybrid signal must spill over *beyond* adjacent channels to accommodate the digital sidebands. So, for example, an AM hybrid signal at an analog center frequency of 710 kHz (like WOR New York) actually covers ± 15 kHz from 695 to 725 kHz for a bandwidth of 30 kHz, which causes harmful interference not only to the adjacent channels of 700 and 720 kHz, but also results in low-level interference at 690 and 730 kHz. In any case, the digital spillover isn't considered a problem for the average AM/FM *listener* who normally wouldn't attempt to receive signals adjacent to a local radio station, but for a *DXer* with specialized equipment capable of receiving signals on adjacent channels, the hybrid digital signal is a source of significant interference and perturbation.

Broadcast engineers also face challenges implementing IBOC digital. Older transmission equipment may not be designed to handle a wideband signal. Extensive modifications like "digital-ready" transmitter replacement may be required, especially for AM. Many AM radio stations use highly directional antennas to prevent interference with co-channel and adjacent signals due to the nature of distant groundwave coverage and skywave propagation on mediumwave frequencies. The directional signal is typically achieved with a phased array of antennas tuned to a very narrow bandwidth for maximum efficiency. A directional AM antenna array is easily identified by a cluster or row of tall antenna towers. Problems with overload, distortion, spurs, and other forms of interference may occur with such an array.

In some cases, AM signals are diplexed or multiplexed into the same antenna(s) to conserve real estate. In other words, more than one signal is transmitted via the same antenna(s). This leads to further challenges for engineers who must deal with interference between the coexisting digital signals, in addition to issues with analog inherent to multiplexing. For many low-power local AM broadcasters operating on tight budgets, often barely able to break even from month to month, conversion to IBOC digital is an expensive proposition that cannot be justified.

Although the installation of new transmission equipment is required for FM digital, upgrading hasn't been as problematic as with AM. Interleaving the FM digital sideband signal with the

analog has gone relatively smoothly in comparison to AM. Unlike AM, most FM antenna systems are omnidirectional because VHF reception is typically line of sight. FM signals only propagate over long distances under rare atmospheric conditions, and at such low signal levels that interference with local radio stations is unlikely. Probably most problems encountered by FM broadcast engineers have been in urban areas where FM antennas may interact due to being located in close proximity or sharing the same tower.

The All-Digital Mode—No Timetable...Yet

As the IBOC hybrid mode gains acceptance among broadcasters, manufacturers, and the public, the next step will be conversion to an all-digital mode. Although conversion to the all-digital mode is foreseeable, analog signals aren't expected to be phased out for a while. A timetable for mandatory conversion to all-digital radio remains undetermined.

In the all-digital mode, the analog portion of the hybrid signal is replaced entirely by digital, thus providing more bandwidth to maximize digital capabilities. The digital signal would then use the full power of the former analog signal for improved robustness and coverage area. Under current specifications, the overall bandwidth of the all-digital signal would be slightly *decreased* to reduce adjacent channel interference, because some of the extra bandwidth occupied by the fringe digital sidebands in the hybrid mode would no longer be necessary. However, all-digital AM and FM would still occupy at least a portion of adjacent channel bandwidth, so the slight reduction in bandwidth would be of little consolation to broadcast DXers.

AM Digital's Future?

The success of FM digital has become apparent, yet the future of AM digital remains clouded due to adjacent channel and nighttime skywave interference concerns. Right now, AM digital broadcasting is limited to daytime only, or "critical hours" between 6 a.m. and 6 p.m. during the shorter daylight of winter. AM broadcasts must revert to analog-only overnight. Full-time AM digital operation on a case-by-case basis is under consideration by the FCC, but still far from receiving final approval. So don't plan on mothballing your analog radios anytime in the near future.

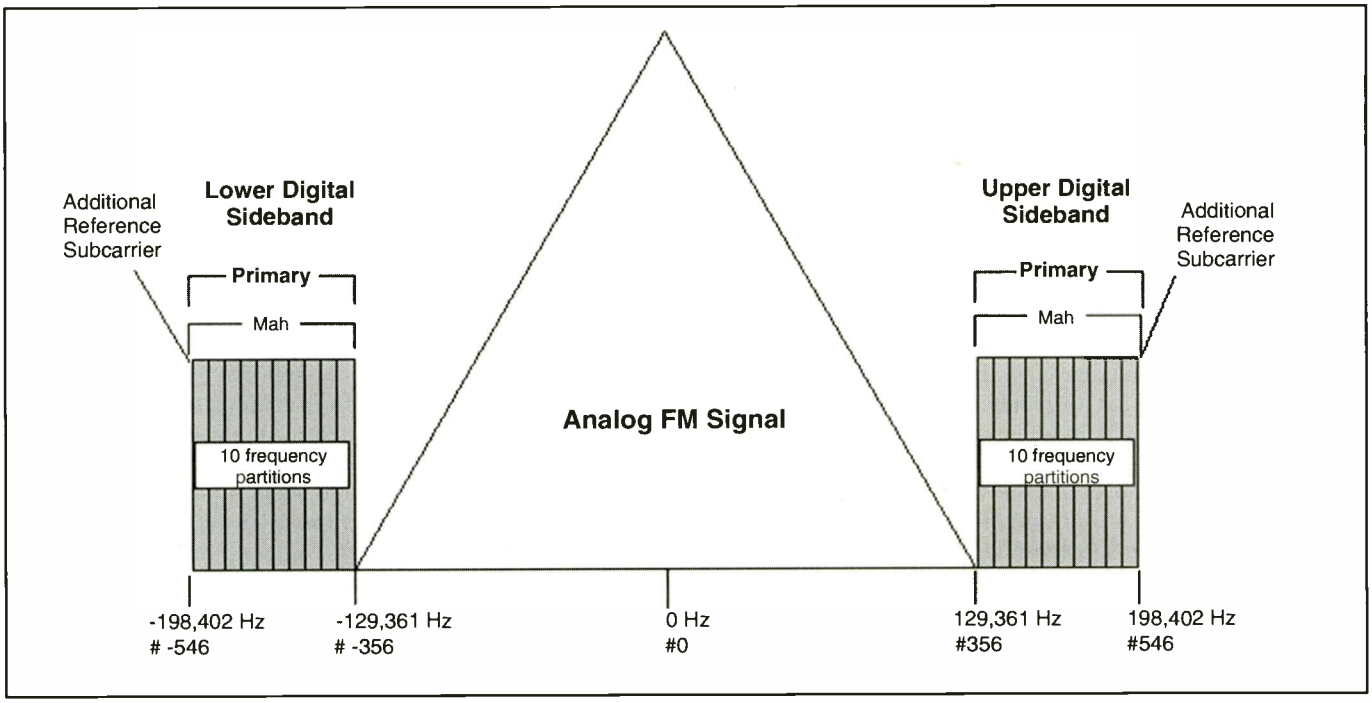
Meanwhile, radiowave interference isn't the only issue facing AM IBOC digital. Kahn Communications has filed suit in federal court against the implementation of AM digital. Details of the lawsuit could not be released prior to court proceedings, but it can be assumed to involve adjacent channel interference, and the exclusivity of a single digital standard approved by the FCC. This isn't the first time Kahn has attempted to stop AM digital. Kahn petitioned the Commisssion in 2003 to reevaluate approval of AM digital, citing increased interference and expenditures that would force independent rural broadcasters out of business, while rendering nearly a half-billion radios obsolete. Kahn offers its own solution, called Cam-D, to improving AM performance in a manner fully compatible with existing analog technology and without increased interference.

No matter what happens, the future of AM radio hangs in the balance between progress in the form of digital modernization and what radio stations like 1620 WNAR proudly broadcast in good old reliable "ancient modulation."

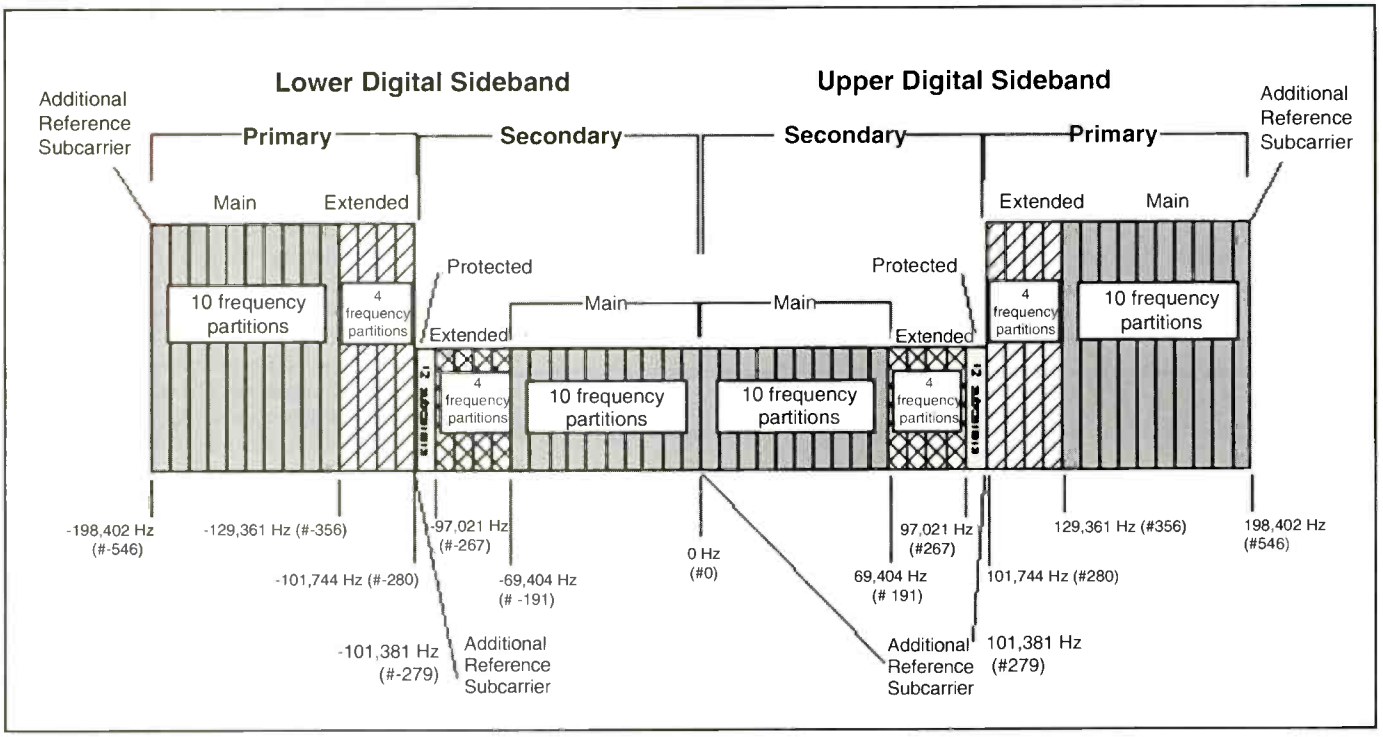
One more note for those interested in AM/FM digital radio, Boston Acoustics has dropped the price of its introductory Receptor HD Radio table model. The radio is reported to be flying off the shelves. Right now, this is the radio to get if you want to be among the first to experience digital radio. As HD radio takes off, we'll be bringing you more details right here in "Broadcast Technology." See you again next month!

Broadcast Loggings

AM "ancient modulation" DXers are receiving plenty of outstanding signals



The FM IBOC hybrid waveform.



The FM all-digital waveform.

with solar activity at its minimum. Here are a few selected logs. All times are UTC.

162 Radio France Inter, Allouis, France, at 0334 with a strong signal, French talk and music, heard on my Zenith Trans-Oceanic 7000, without using any external antenna. (Yost, MI)

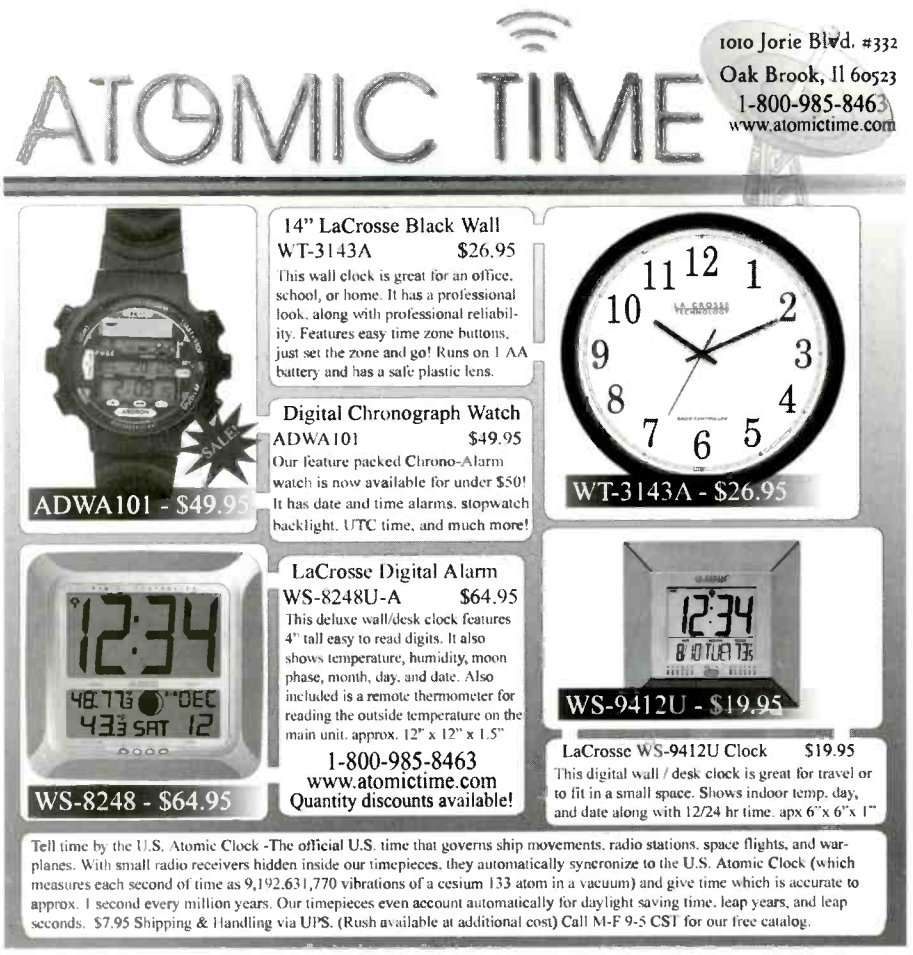
183 Europe 1, Felsberg, Germany, at 0310 with French talk, the strongest signal I have yet heard from any longwave broadcast station. I could even detect it using my 80-meter vertical, at a moderate level, so I decided to see if I could hear it on my transistorized '70s vintage Zenith Trans-Oceanic Royal 7000, using only its internal ferrite rod antenna. I could. Incredible! (Yost, MI)

225 Polskie Radio, Solec Kujawski, Poland, at 0512 loud and clear with a man in Polish and pop tunes including Bryan Adams' "I Do It For You" and Sting's "Fields of Gold." (DeLorenzo, MA)

531 DRS Beromunster, Switzerland, at 0500 with polka music that sure didn't sound like Spain. Easily paralleled to the DX Tuners signal on an Irish receiver. Mostly under co-channel RNE Spain during the hour I listened, but that polka music cuts through very nicely. ID, "Hier ist Musigwall, good morgen," pips, then news in German. (Renfrew, NY)

550 KLLV Breen, Colorado, at 1655 faded in after I lost KFYI Phoenix, Arizona, which was running the "nearly famous Barry Young Show." All Christian programming, ID as K-Love. (Barton, NM)

570 KNRS Salt Lake City, Utah, at 0350 with Mike Reagan talk program. Good IDs at start of Fox News on the top of the hour. (Barton, AZ)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580 KMJ Fresno, California, at 1333 a tough copy mixing with two other stations, heard ID along with "News/Talk 580" slogan. (Barton, AZ)

585 Radio Nacional de Espana, Madrid, Spain, at 0245 with a great flamenco music program. Time pips at :00, then jingle into "Radio Nacional de Espana; Informativo" news. Very good on peaks with minor slop from adjacent signals. (Chiochiu, QC)

600 KOGO San Diego, California, heard at 1325 with a Dr. Dean Edell short take, then morning local area news. (Barton, AZ)

630 Radio Progreso, Pinar del Rio, Cuba, at 0422 heard with "Nocturno" program of adult contemporary music, mixing with CHLT Sherbrooke and WPRO Providence, parallel 640 and 890 kHz. 890 had the best signal. Rare! (Chiochiu, QC)

710 Radio Rebelde, Cuba, at 0445 with news summary of the day. This was the dominant signal on 710, and not co-channel WOR New York which only from time to time topped the frequency later in the night. (Chiochiu, QC)

720 RDP1 synchros, Portugal, at 0422 a Portuguese vocal, then fast talk; occasionally over the CHTN, YVQE, and WGN mélange. CHTN reducing its signal this way has made 720 a much more viable transatlantic channel. (Connelly, MA)

927 VRT Radio Een, Wolvertem, Belgium, at 0200 a brief German newscast, then several alternative rock and pop/cabaret style vocals. Material possibly included Laurie Anderson, Tori Amos, and Dido. Belgium not listed on at this time per the *European Medium Wave Guide*. After hearing this with a good signal, I checked DX Tuners. Same station noted on the Waterford, Ireland and Folkestone, UK receivers but surprisingly not dominant on Stuttgart, Germany, which had a 3-station mix. Bruce Conti mentioned Belgium on air outside of listed schedule hours. Local 1510 WWZN wiped out chances to see if 1512 was parallel. (Connelly, MA) At 0350 good with a French pop vocal, then a Radio Een ID into a rock vocal, later Melanie "Candles in the Rain" parallel www.radio1.be streaming audio. New. (Conti, NH)

999 Voice of Russia/RMR, Maiac, Moldova, at 2215 good with news in Russian, then pop music, following a now familiar format of music with news breaks every 15 minutes, over COPE Spain futbol play-by-play. (Conti, NH)

1026 SER synchros, Spain, at 0259 with a Cadena Ser promo, 5+1 pips at 0300, "Cadena Ser, Servicios Informativos" ID, time check, "son las cuatro, las tres in Canarias," new. (Renfrew, NY)

1080 WVCG Coral Gables, Florida, at 0348 with urban contemporary gospel music and a choppy signal underneath WKJK Louisville, Kentucky, for the most part, but it would cover WKJK at times. IDs as "Newstalk 1080, WVCG" and "Radio One...The People's Station." (New, GA)

1140 KNWQ Palm Springs, California, at 0515 with "Marshall and Stone" talk show discussing Riverside County bomb hoax , usual ID only as "K-News" and mentions of "1140 and 970 AM." (Barton, AZ)

1380 KHEY El Paso, Texas, at 0445 with sports talk, spots for El Paso-area businesses, ID and news at the top of the hour, faded out after that with local sunset. (Barton, AZ)

1490 WPCI Greenville, South Carolina, at 2303 with blues music fading in and out of the static, and a decent signal as the station identification was announced, only to then fade into the static, "This is WPCI, Greenville, AM Stereo for 1490." (New, GA)

1540 WOGR Charlotte, North Carolina, at 2330 with gospel music and a decent signal in and out of the static; "You're listening to WOGR Charlotte... Word of God Radio." (New-GA)

Thanks this month to Rick Barton, Bogdan Chiochiu, Mark Connelly, Marc DeLorenzo, Bert New, Jim Renfrew, and Scott Yost. 73 and Good DX! ■

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